

Commonwealth of Kentucky
Division for Air Quality
PERMIT STATEMENT OF BASIS

(DRAFT)

Conditional Major / Synthetic Minor, Construction / Operating

Permit: F-07-047

The Four Rivers BioEnergy Company, Inc.

Calvert City, KY 42029

September 25, 2007

IL-Won Shin, Reviewer

SOURCE ID: 21-157-00066

AGENCY INTEREST: 97253

ACTIVITY: APE20070001

SOURCE DESCRIPTION:

The Four Rivers BioEnergy Company, Inc. (Four Rivers) is proposing to construct a new biofuels facility to manufacture both biodiesel and ethanol in Calvert City, Marshall County, Kentucky. The plant will manufacture biodiesel at a rate of 38.5 million gallons per year and fuel grade ethanol at a rate of 115.5 million gallons per year. The primary energy source for the facility will be natural gas fired package boilers. A description of each of the processes, including associated control equipment, is provided below.

Four Rivers plans to construct the biodiesel facility first and then the ethanol manufacturing plant. Initially, steam generation at the biodiesel facility will be provided by a small boiler. However, once the ethanol plant is constructed all steam generation required for both ethanol and biodiesel manufacturing will be provided by two large boilers installed at the ethanol plant. This operational limit is necessary to maintain the biofuel facility operations below major source thresholds.

Biodiesel Production

Biodiesel fuel is produced via a series of chemical reactions. The feedstock soybean oil, in essence, undergoes transesterification, the chemical reaction of triglycerides with an alcohol in the presence of a catalyst to form mono-alkyl ester and glycerin. Oils or fats and methanol are converted to methyl ester (biodiesel) in the presence of a homogeneous alkaline catalyst in two mixer-settler type units arranged in series. After sufficient reaction time, the insoluble glycerin reaction products are removed in separation units. A description of the overall Biodiesel manufacturing processes is provided below.

1. Unit 10 – Transesterification Process

Transesterification is based on the chemical reaction of triglycerides with methanol to form methyl ester and glycerin in the presence of an alkaline catalyst. The conversion is accomplished in mixer-settler units. The reaction proper occurs in the mixers (reactors). The reaction products form two distinct phases and are separated in the settlers. The ester-rich phase obtained is upgraded to methyl ester by washing. The glycerin-rich phase is freed from methanol.

The selected transesterification process flow is similar to a cross flow. The feedstock and the intermediate product, respectively, flow successively through the two mixer-settler units. Both units are supplied with methanol and catalyst in parallel. The reactors are of multi-stage design, comprising various reaction chambers in order to achieve maximum conversion efficiency to methyl ester. The settlers allow phase separation to virtually approach the limit of solubility. This is of great benefit for the downstream processing of the phases rich in ester and glycerin. This process configuration is supported by a defined temperature profile adjusted along the mixer-settler arrangement.

The catalyst in liquid form is added to the methanol by means of metering pumps. Since the catalyst is sensitive to water, the catalyst pump tank may be protected with a nitrogen layer. All gases vented from the mixer-settler, from the catalyst pump tank and the methanol pump tank are routed to a condenser where they are partly condensed and returned to the process in liquid form.

Methyl Ester Washing

The ester-rich phase still contains methanol, glycerin, small amounts of catalyst, traces of soaps and high boiling components. In order to remove the water-soluble substances, the ester phase is washed. To avoid the formation of emulsions, any soaps that may be present are split before washing by adding acid. Dilute hydrochloric acid (3.7% strength) is prepared automatically and can be added to the methyl ester to be washed.

2. Unit 11 – Methyl Ester Drying (and Methanol Recovery)

The washed ester contains some water so it is vacuum-dried in a dryer circuit to adjust the allowable water content. The dried methyl ester is continuously delivered by pump to the methyl ester storage tank in the tank farm.

Methanol Recovery

Because of its methanol and glycerin contents, the high-glycerin phase is collected in a pump tank together with the wash water. In this process, the catalyst decomposes into caustic soda solution and methanol in the presence of water. The methanol-bearing aqueous phases of Unit 10 and 11 are collected and then fed to a rectification column. The overhead product has a methanol content of > 99.9% and is recycled to the transesterification process via the methanol pump tank.

3. Unit 12 – Glycerin Water Pretreatment Stage

The pretreatment stage for glycerin water or sweet water is a chemical-physical process step to separate not fully converted oil and soaps that form during transesterification. To remove still existent companion substances, such as non-converted oils and soaps having formed in the process, the glycerin water mixture accumulating at the bottom of the rectification column is fed to a separator. In the separator, the reaction products float up, being separated as the so-called fatty phase.

Following the separation of the fatty phase, the glycerin water is neutralized with caustic soda solution in an agitated vessel. After undergoing the above-described treatment, the glycerin water with a glycerin concentration of 35 to 40% is passed to the downstream evaporation plant for further concentration.

4. Unit 14 – Glycerin Water Evaporation System

The glycerin water or sweet water mixture proceeding from the pretreatment stage is enriched in a 2-stage evaporation system (optional 3-stages) up to a glycerin concentration of at least 80%. The pretreated glycerin water mixture is delivered by a feed pump to the recirculation circuit of the evaporation system. The evaporator system has two recirculating evaporation circuits (stages). Each recirculating evaporation circuit is composed of a heat exchanger and evaporator section. Upon leaving the heat exchanger, the recirculated mixture is fed to the evaporator where the evaporated gas phase is liberated and separated from the liquid phase.

The first heat exchanger is heated indirectly by means of heating steam, whereas the second (and optional third) stage is heated by means of the vapors from the preceding stage. The vapors from the last evaporator stage are precipitated in a condenser. The vacuum is maintained by means of a water ring seal pump.

The concentrated solution, with a final glycerin concentration of about 80% to 85% is transferred to a storage tank (by owner) for storage and sale. An optional process (Unit 16) can be added to produce pharmaceutical grade glycerin from the 80% crude glycerin by-product.

Vent scrubber system

All process vessels in units 10-14 which may contain methanol are connected to a vent system. This vent system is first fed to a pre-condenser to remove all condensable vapors and then sent to a two stage vent scrubber before entering the process flare where the remaining methanol VOC is destroyed by combustion. All methanol scrubbed from the process vents is recycled back to the process.

5. Unit 16 – Pharmaceutical Grade Glycerin

Raw glycerin feed at 80% to 85% concentration is fed to the pharmaceutical glycerin process. The feed glycerin is partially dried of moisture in a closed loop dryer. The conditioned feed exchanges heat with distilled glycerin to conserve energy. The preheated feed enters the glycerin still where it is continuously separated into three streams. The intermediate stream is the unbleached pharmaceutical grade glycerin, the overhead stream is the lower grade Glycerin 2 (approximately 3 to 5% of product glycerin), and the bottoms stream is sent to additional batch distillation for recovery of glycerin.

The unbleached product glycerin is passed through fixed bed activated carbon to produce the final pharmaceutical grade glycerin finished product. The Glycerin 2 material is reserved for batch processing into pharmaceutical glycerine or sold as a lower grade glycerine by-product.

6. Unit 20 – Tank Farm

Various tanks and transfer equipment for inbound materials, intermediary products and refined products along with an HCL scrubber package to address HCL storage. Tanks include storage tanks for soy oil (a raw material) and biodiesel product.

7. Unit 30 – Utilities

- a. Cooling Tower at 7,00 gpm
- b. Boiler with Deaerator and Blowdown Separator at 70,000 ppm
- c. VOC Abatement Flare

8. Unit 57 – Biodiesel Filtration

- a. Pressure Leaf Filter
- b. Slurry Tank
- c. Filtered ME Tank
- d. DE Bulk Tote Bag System

9. Miscellaneous Equipment and Sources

- a. Various pumps, valves, and piping
- b. Emergency Generator
- c. Small tanks or vessels with negligible emissions
- d. Plant Roads (will be paved)

Ethanol Production

Ethanol is produced via a series of physical and chemical processes. The feedstock, corn, is milled, fermented and distilled to produce 200 proof (100%) ethanol. The facility will be powered by state-of-the-art natural gas combustion. A description of the process, including associated control equipment, is provided below.

The facility will purchase feedstock (corn) and receive it at the facility by rail, truck, and barge. Grain delivered by truck will be sampled and graded at the plant entrance then unloaded into truck-receiving pits. Grain received by rail will be transferred via the rail unloading conveyor. Barge unloading of grain will be completed with clamshell machines. The clamshell will unload the barge to a series of open conveyors that transfer the grain to an elevator leg and storage. The annual grain-unloading rate is estimated at 1,155,000 tons per year based on the maximum denatured ethanol production rate of 115.5 million gallons per year.

The grain receiving pits will be located in a partial enclosure. An example of a partial enclosure is a building over the grain receiving pits (large enough to enclose a haul truck and railcar), but the overhead doors are usually open during the transfer of grain between the truck/railcar and pit. The partial enclosure is used to block the effects of the wind. The receiving pits are fitted with conveyors, which transfer the grain to the elevator legs and then to the grain storage silos. Grain from the open barge is transferred via conveyors to the receiving pits, then to the elevator leg and to the grain storage silos. The grain receiving baghouse (**Source ID#, S1**) controls emissions from the receiving pits and associated grain transfer points. Dust from the baghouse is returned to the process. The grain storage operation consists of two (2) 600,000-bushel capacity storage silos, grain elevator legs, and associated conveyors.

A high efficiency baghouse will collect and control particulate emissions associated with receiving pits. Mechanical conveyors move the grain from receiving to storage, storage to milling, and milling to mixers. The high efficiency baghouses (**S2 and S3**) are connected to these conveyors as well; to ensure particulate emission controls for all grain processing areas. Collected grain dust is returned to the process downstream of the hammermill. A hammermill is a dry milling process used to mill the grain into a powder. Hammermill particulate emissions are controlled by individual high efficiency vent filters on each mill and a common stack. Dust collected by the milling baghouse is injected into the mixers. (**S4**)

In the mixer, the powdered grain is mixed with recycled process water from the cook water tank to form a slurry. The slurry is cooked to liquefy and breakdown the starch to sugars. The slurry is cooled with non-contact cooling water and pumped to fermenter process vessels where yeast and enzymes are added. The fermentation process converts the sugars to ethanol and carbon dioxide (CO₂) and produces a fermented mash or slurry called beer. The beer is pumped from the fermenters to the beer well. The beer well is a process tank that provides a continuous flow of beer slurry to the degasser and the beer column. The gases from the fermenters and beer well pass through a high efficiency CO₂ scrubber to remove residual amounts of ethanol and other volatile organic compounds (VOCs) before it is exhausted to a regenerative thermal oxidizer (RTO) for secondary control. (**S10**) The exhaust gas is comprised primarily of CO₂. The water from the scrubber is pumped to the cook water tank and recycled back to the process.

The beer contains about 10% ethanol in addition to non-fermentable corn solids. The ethanol is

separated from the beer by distillation and leaves the distillation section as 190 proof ethanol. At this point in the process, the ethanol contains residual water. To remove the residual water, the 190 proof ethanol is passed through a molecular sieve resulting in 200 proof ethanol. The 200 proof ethanol is sent to an internal floating roof storage tank. The final process step mixes the 200 proof ethanol with natural gasoline to create a mixture of 95% ethanol and 5% denaturant. The denaturing step is conducted to comply with applicable Alcohol Tobacco Tax and Trade Bureau (TTB) requirements. Denaturant is also stored within an internal floating roof tank. The denatured ethanol is stored in one of two internal floating roof tanks. Loading of liquid product to truck, barge, and railcars is controlled with the use of industrial flares. **(S12 and S16)**

Vapors from the various process equipment and vents are vented to one (1) carbon dioxide scrubber. The dryer exhaust and centrifuge vents are vented to a RTO for emissions control. The RTOs serve to control VOCs/HAPs and will also marginally control PM/PM₁₀ emissions (including condensables).

The distillation process removes the non-fermentable corn solids and water from the process stream. The residue mash leaving distillation, called whole stillage, is transferred from the base of the beer column to the stillage processing area. The whole stillage goes into a whole stillage tank and then passes through a centrifuge to remove the majority of the water. The underflow from the centrifuge is called wet distiller's grain (WDG) or wet cake. The facility will have the option to handle WDG in two ways:

1. The WDG can be blended with syrup and dried to create a product known as dried distillers grains and solubles (DDGS). The DDGS is about 10% moisture and can be stored for long periods of time. Upon leaving the drying system, the DDGS must be cooled prior to storage or loadout. **(S9 and S17)** The facility will utilize two (2) fluid bed coolers for DDGS cooling. **(S5 and S6)** The DDGS storage and loadout system is vented to a high efficiency baghouse **(S7)** for particulate emission control.
2. The facility can also sell WDG. It is collected on an open pad, and then front-end loaders transfer the WDG to trucks for distribution to a local market.

The DDGS drying operations consist of two (2) ring dryers. The drying is accomplished by direct contact with hot gases. The emissions from the DDGS dryer are also controlled by the RTOs. The facility will have two (2) RTOs. The DDGS dryer will use natural gas as the primary fuel. The emissions from the DDGS cooling system are controlled by a high efficiency baghouse collection system.

The overflow from the centrifuges, called thin stillage, enters the centrate tank and then a thin stillage tank prior to passing through a set of evaporators. The evaporators reduce water content. The concentrated stream from the evaporator and syrup is mixed with the centrifuge underflow stream (or added later) before entering the dryer. The condensed water from the evaporators goes to the anaerobic treatment module (ATM). The ATM is an anaerobic biological water treatment system that converts organic material in the process water into bio gas (primarily methane). The methane is routed to the ATM's high efficiency flare system **(S13)** or to the burner of one of the RTOs. The water from the ATM is recycled to the cook water tank for reuse in the process. No process water is discharged to the environment.

The facility is equipped with a water cooling tower **(S15)** that will provide non-contact cooling for

various processes. Cooling tower blowdown (non-process utility water) will be discharged in accordance with applicable requirements.

The vapors produced in the distillation, dehydration, and evaporators are condensed with any uncondensed material controlled by the RTO. The two (2) RTO system serves as the primary emission control device for the dryer and centrifuge vents. The RTOs serve as a secondary control to the fermentation scrubber. The systems are very efficient at reducing PM, PM10, Carbon Monoxide (CO), VOCs, and HAPs. The RTO system will exhaust through a common stack.

The facility has incorporated emergency equipment as a safety precaution. The emergency equipment consists of an emergency fire water pump (**S14**) and is limited to 100 non-emergency hours of operation per year. Non-emergency operating hours for the engine include maintenance and testing activities. If there is an emergency that requires the fire water pump, it is expected that the rest of the facility will be shut down.

Since the emergency equipment is diesel-fired, a diesel storage tank will be installed. The tank will have a capacity of 250 gallons or less. Due to the small tank size, low volume throughput, and low vapor pressure of diesel, emissions associated with this tank are negligible.

The facility is equipped with two (2) natural gas-fired boilers (**S11**) to produce steam for the ethanol plant. The boilers will exhaust through a common stack and will employ ultra-low NO_x burners. The boilers installed with the ethanol plant will also supply the biodiesel plant with necessary steam. Once the ethanol plant is operational, the biodiesel plant boiler will not operate unless the ethanol plant boilers are down.

COMMENTS:

Biodiesel Production

Air emission stack parameters at the Four Rivers biodiesel facility are provided in Table 1. The process units are proposed along with air emissions and air pollution control equipment as shown in Table 2 with the corresponding Biodiesel Plant Stack (BS).

**Table 1. Air Emission Stack Parameters
Four Rivers BioEnergy Biodiesel Plant
Calvert City, Kentucky**

Process/ Activity	Emission Unit	Stack ID	Diameter (in.)	Height (ft.)	Flow Rate (acfm)	Exit Temp (F)	Exit Velocity (fps)
Biodiesel Process Vent Flare	Enclosed Flare	BS1	24	90	2,120	1,600	11
Glycerin Vacuum Condenser	Glycerin Plant	BS2	2	55	9	105	6
Hydrochloric Acid Scrubber	Wet Scrubber	BS3	4	20	27	Ambient	5
Cooling Tower Exhaust	Cooling Tower	BS4	204	25	516,600	Ambient	38
Boiler*	Steam Boiler	BS5	36	35	21,504	575	51
Emergency Generator Exhaust**	Emergency Fire Water Pump	BS6	3	8	1,000	815	340

* The boiler will be constructed in support of biodiesel manufacturing. However, once the ethanol plant is operational, this source will only operate when the ethanol boilers are not.

** This emergency fire water pump will be constructed in the same phase as the biodiesel facility; however, it will provide emergency operations to both the ethanol and biodiesel facilities.

Type of control and efficiency

The following provides a description of the air pollution control equipment utilized at the biodiesel plant. All equipment will be installed, operated and maintained according to manufacturer specifications and as permitted. The following Biodiesel Plant Control Equipment (BCE) will be utilized, BCE 1 to BCE 5.

1. BCE 1: Process Vent Flare.

A variety of processes eventually vent through a series of condensers or scrubbers, and/or directly to the flare. The equipment inventory in Table 2 provides where each unit is controlled and where it exhausts to the atmosphere.

2. BCE 2: Air Scrubber.

This is one of the units used to control vapors from various processes as listed in Table 2. It also exhausts to the flare for control prior to atmospheric release.

3. BCE 3: Vent Condenser.

This is one of the units used to control vapors from various processes as listed in Table 2. It exhausts to a scrubber and ultimately to the flare for control prior to atmospheric release.

4. BCE 4: Glycerin Vacuum Condensers.

This system provides controls of various process vapors prior to release to the atmosphere.

5. BCE 5: HCL Acid Scrubber.

This system controls acid emissions prior to release to the atmosphere.

6. Various pumps, valves and flanges designed for light liquid or gaseous service.

Piping, pumps and valves are constructed, operated and maintained in accordance with the applicable requirements of 40 CFR 60 Subpart VV.

Table 2. Emission Source and Control Equipment Inventory
Four Rivers BioEnergy Biodiesel Plant
Calvert City, Kentucky

Emission Units	Stack ID	Description	Type of Control	Efficiency
<i>Unit 10 - Transesterification</i>				
100	BS 1	Reactor #1	BCE 3: Vent Condenser	85% (VOC/HAP)
101		Reactor #1 Separator		
102		Reactor #2		
103		Reactor #2 Separator		
104		Methanol Column		
105		Methyl Ester (ME) Washing Column	BCE 2: Air Scrubber	99.9% (VOC/HAP)
106		Exhaust Air Scrubber		
107		Wash Water Phase Separator		
108		Maturity Reactor - ME Wash		
109		Vent Condenser	BCE 3: Vent Condenser	85% (VOC/HAP)
110		Methanol Column OVHD Condenser		
111		Methanol Surge Tank		
112		Methylate Surge Tank		
113		Wash Water Tank	BCE 2: Air Scrubber	99.9% (VOC/HAP)
114		Methanol Column Reflux Drum	BCE 3: Vent Condenser	85% (VOC/HAP)
115		Collection Tank	BCE 2: Air Scrubber	99.9% (VOC/HAP)

Emission Units	Stack ID	Description	Type of Control	Efficiency
Unit 11 - ME Drying				
116	BS 1	ME Dryer 1 st Stage	BCE 2: Air Scrubber	99.9% (VOC/HAP)
117		Drier 2 nd Stage		
118		ME Dryer Tank		
119		ME Dryer Vacuum System		
Unit 12 - Glycerin Neutralization				
120	BS 1	Glycerin - Fat Separator	BCE 2: Air Scrubber	99.9% (VOC/HAP)
121		Glycerin Neutralization Reactor		
122		Fatty Matter Collecting Vessel		
123		Glycerin Water Receiver		
Unit 14 - Glycerin Evaporation				
124	BS 1	1 st Effect Separator	BCE 2: Air Scrubber	99.9% (VOC/HAP)
125		2 nd Effect Separator		
126		Final Condenser		
127		Unit 14 Vacuum System		
Unit 16 - Glycerin Refining				
128	BS 2	Dryer	BCE 4: Glycerin Vacuum Condensers	85% (VOC/HAP)
129		Distillation Column		
130	No Stack	Bleaching Vessel	No Control	N/A
131		Bleaching Vessel		
132		Bleaching Vessel		

Emission Units	Stack ID	Description	Type of Control	Efficiency
133	BS 2	Overhead Condenser	BCE 4: Glycerin Vacuum Condensers	85% (VOC/HAP)
134		Glycerin I Receiver		
135		Glycerin II Receiver		
136	No Stack	Hot Well	No Control	N/A
137		Glycerin Receiver		
138	BS 2	Residue Still	BCE 4: Glycerin Vacuum Condensers	85% (VOC/HAP)
139		Residue Still		
140		Glycerin Distillation Vacuum System		
Unit 20 - Tank Farm				
141	BS 1	Methanol	BCE 1: Process Vent Flare	99.9% (VOC/HAP)
142		Sodium Methylate Tank		
143	BS 3	37% HCL Acid Tank	BCE 5: HCL Acid Scrubber	95% (VOC/HAP)
144	No Stack	Glycerin Water Tank	No Control	N/A
145		Diesel Fuel Tank		
146		Crude Glycerin (80%) Tank		
147		USP Glycerin Tank		
148		Biodiesel (RME) Tank		
149		Biodiesel (RME) Tank		
150		Neutral Oil Tank (Soybean Oil)		
151	BS 3	HCL Scrubber Package	BCE 5: HCL Acid Scrubber	95% (VOC/HAP)

Emission Units	Stack ID	Description	Type of Control	Efficiency
<i>Unit 30 - Utilities</i>				
152	BS 4	Cooling Tower	No Control	N/A
153	BS 5	Boiler with Deaerater & Blow Down Separator	No Control	N/A
154	No Stack	Degasser	No Control	N/A
155	BS 1	VOC Abatement Flare	BCE 1: Process Vent Flare	99.9% (VOC/HAP)
<i>Unit 57 - Biodiesel Filtration</i>				
156	No Stack	Pressure Leaf Filter	No Control	N/A
157	No Stack	Slurry Tank	No Control	N/A
158		Filtered ME Tank		
159		DE Bulk Bag System		
160		Soybean Oil Tank (Secondary Tank Farm)		
161	No Stack	Biodiesel Tank (Secondary Tank Farm)	No Control	N/A
162	BS 6	Emergency Generator (For Both Plants)	No Control	N/A

Ethanol Production

Air emission stack parameters at the Four Rivers ethanol facility are provided in Table 3.

**Table 3. Air Emission Stack Parameters
Four Rivers BioEnergy Ethanol Plant
Calvert City, Kentucky**

Emission Point ID	Source ID	Diameter (inches)	Height (feet)	Flow (acfm)	Temperature (degrees F)
S1	Grain Unloading Baghouse	44	30	45,000	68 (Ambient)
S2	Reclaim Baghouse	12	30	5,000	68 (Ambient)
S3	Milling Baghouse	38	30	28,800	68 (Ambient)
S4	Dust Collection Filter Receiver	10	30	500	68 (Ambient)
S5 & S6	DDGS Cooler and Cooling System Baghouse	36	30	21,000	100
S7	DDGS Transfer Baghouse	10	30	5,000	68 (Ambient)
S9	DDGS Rail Loading Spout with filter module	12	25	3,600	100
S10	Fermentation (CO ₂) Scrubber, Dryers/RTOs Stack	96	100	174,000	315
S11	Natural Gas-Fired Boilers	72	50	85,000	350
S12	Ethanol Loadout Flare (shared truck and railcar)	20	25	1,500	1,800
S13	ATM Flare	17	22	Naturally aspirated	1,800
S14	Emergency Fire Water Pump	3	8	1,000	815
S15	Cooling Tower	360	40	1,000,000	85
S16	Ethanol Loadout Flare (barge)	TBD	TBD	TBD	TBD
S17	DDGS Barge Loading Spout with filter module	TBD	TBD	TBD	TBD

The following equipment (or equivalent) is proposed along with air emissions.

1. Grain Receiving, Storing & Processing Facilities
 - a. Two (2) grain storage bins or silos of approximately 600,000 bushels of storage capacity each.
 - b. Receiving equipment truck (2) and rail (1) (20,000 and 40,000 bushels/hr maximum capacity, respectively), one (1) day surge bin with a storage capacity of 10,000 bushels and four (4) hammermills (6,600 bushels/hr, combined capacity).
 - c. Equipment necessary for barge transfer activities; including clamshell cranes, conveyors, etc. for grain.
2. One (1) Ethanol Manufacturing Plant includes storage tanks, various pumps, piping and valves, fermentation process vessels, CO₂ scrubber, distillation units, molecular sieves, condensers, centrifuges, evaporators, DDGS dryers, methanator and product loadout.

Specific Plant Equipment:

- a. One (1) Tank – 300,000 Gallons designed to store 190 proof (95%) ethanol. The tank is equipped with an internal floating roof and seal system that meets the applicable requirements of 40 CFR Part 60, Subpart Kb.
- b. One (1) Tank – 300,000 Gallons designed to store 200 proof (100%) ethanol. The tank is equipped with an internal floating roof and seal system that meets the applicable requirements of 40 CFR Part 60, Subpart Kb.
- c. One (1) Tank – 150,000 Gallons designed to store denaturant (natural gasoline). The tank is equipped with an internal floating roof and seal system that meets the applicable requirements of 40 CFR Part 60, Subpart Kb.
- d. Two (2) Tanks – 1,500,000 Gallons each designed to store product grade denatured ethanol. Each tank is equipped with an internal floating roof and seal system that meets the applicable requirements of 40 CFR Part 60, Subpart Kb.
- e. Piping, Pumps, and Valves: Various pumps, valves, and flanges designed for light liquid service. Piping, pumps, and valves are constructed, operated, and maintained in accordance with the applicable requirements of 40 CFR Part 60, Subpart VV.
- f. Two (2) Dryers designed for drying the wet distillers grain (WDGS). The dryers are rated at a maximum heat input rate of 92 mmBtu per hour and a drying capacity of 43 tons/hour of DDGS.
- g. One (1) Truck/Railcar Loading Terminal designed for transferring denatured ethanol to trucks and railcar for shipment offsite. Loading will utilize submerged filling and be equipped with a shared flare in order to reduce VOC emissions during truck and railcar loadout.

- h. One (1) Cooling Tower provides plant cooling requirement at a design water circulation rate of 46,000 gallons per minute.
- i. One Anaerobic Treatment Module (ATM) to include a flare. This unit treats process wastewater and produces methane. The flare will operate only when the dryer is down, i.e., when the produced fuel gas (primarily methane) will not be supplementing (or offsetting) fuel demand to the dryer.
- j. Plant Roads. All roads on plant property will be paved.
- k. Two (2) 18 mmBtu/hr Regenerative Thermal Oxidizer (RTO) will serve as the primary emission control for the dryer as well as process vents. The RTOs will serve as secondary control to fermentation, receiving CO₂ scrubber exhaust prior to release to the atmosphere.
- l. Grain Receiving and Unloading (truck/rail/barge) designed to control emissions with pits ventilated to a 45,000 cfm baghouse. Barge unloading will be conveyed to rail receiving pits where it will be controlled by the baghouse. Emissions from this control and the transfer blower will be routed to a 500 cfm dust collection filter receiving baghouse.
- m. Mill Surge Bin and Four (4) Hammermills. The surge bin has a capacity of 10,000 bushels and along with conveyers and hammermills (1,650 bushels/hr capacity) each are ventilated to a 28,800 cfm baghouse. An additional 5,000 cfm baghouse will be used to control emissions associated with the surge bin and elevator leg.
- n. Two (2) DDGS Cooling System and a DDGS transport system designed to cool and transport DDGS in an enclosed storage building. Cooling system consists of a fluid bed cooler that exhausts through a 21,000 cfm baghouse to the atmosphere. Transfer will be controlled by a 5,000 cfm baghouse.
- o. One (1) DDGS Storage and Loadout designed to store and handle DDGS by rail and controlled by a 3,600 cfm baghouse.
- p. One (1) Anhydrous Ammonia Storage Tank (30,000 gallon pressure vessel) has no specific air regulatory requirements.
- q. One (1) Corrosion Inhibitor Tank and Several Other Process Tanks will be installed as required by various processes.
- r. One (1) Barge Grain and DDGS Handling System. This series of conveyers and transfers takes grain from barges to the grain silos and DDGS from the storage area to the barges.
- s. One (1) Ethanol Loadout System for transporting and loading ethanol product on barges.
- t. Two (2) Low NO_x Boilers used to generate steam for use in support of facility operations and have a heat input capacity of 150 mmBtu/hr per boiler.

Type of control and efficiency

The following provides a description of the air pollution control equipment designed for the ethanol plant as shown in Table 4. All air pollution control equipment will be properly installed, operated, and maintained at all times whenever the emissions source that it is designated to control is operating.

1. One (1) Grain Unloading Fabric Filter Baghouse for the purpose of controlling particulate matter from grain unloading truck and rail pits, transfer, and the storage silos. The unit is designed for a 45,000 cubic feet per minute flow rate while operating at ambient temperature.
2. One (1) Reclaim Baghouse for the purpose of controlling particulate matter from the mill surge bin to the elevator leg, excluding the hammermills. The unit is designed for a 5,000 cubic feet per minute flow rate while operating at ambient temperature.
3. One (1) Hammermilling Fabric Filter Baghouse for the purpose of controlling particulate emissions from operation of the hammermills. The unit is designed for a 28,800 cubic feet per minute flow rate while operating at ambient temperature.
4. One (1) Dust Collection Filter Receiver Baghouse for the purpose of collecting remaining dust from the unloading baghouse and from the transfer blower. The unit is designed for a 500 cubic feet per minute flow rate while operating at ambient temperature.
5. Two (2) Fluid Bed Coolers with Fabric Filter Baghouse for the purpose of cooling the dried distillers grain and solubles prior to storage and load-out. The fluid bed cooler exhausts to a baghouse which is designed to operate at inlet and outlet gas flow rates of 21,000 cubic feet per minute.
6. One (1) DDGS Loadout Fabric Filter and Transfer Baghouse for the purpose of collecting dust from the DDGS storage and loadout operation. The baghouse is designed to operate at 5,000 cfm. One (1) DDGS Loading Baghouse for rail at a 3,600 cubic feet per minute capacity and a barge loadout baghouse will be determined later.
7. One (1) CO₂ Scrubber for the purpose of removing residual ethanol prior to venting to one of the two RTOs.
8. Two (2) Loadout Flares for the purpose of controlling VOC emissions from truck/railcar and barge transfer activities.
9. Two (2) Regenerative Thermal Oxidizers (RTOs) are fired with natural gas and designed for a maximum heat input rate of 18 mmBtu per hour each. The exhaust emissions from the DDGS dryer, hydrolysis equipment, various tanks, distillation process, and stillage processes including some digester gases, are to be directed to the RTOs whenever the ethanol plant is operating. The RTOs will also receive CO₂ scrubber exhaust as a secondary control prior to discharge to the atmosphere. The RTOs will minimize potential for nuisance odor from the dryer and process vents and provide particulate and VOC control.
10. One (1) ATM Flare for the purpose of controlling methane emissions from the anaerobic treatment module. The ATM gases are directed to the flare whenever the dryer is not operating.

Table 4. Emission Source and Control Equipment Inventory
Four Rivers BioEnergy Ethanol Plant
Calvert City, Kentucky

Source ID	Description	Type of Control	Efficiency
S1	Grain Unloading	Baghouse	80% (PM/PM ₁₀)
S2	Reclaim	Baghouse	80% (PM/PM ₁₀)
S3	Grain Milling	Baghouse	95% (PM/PM ₁₀)
S4	Dust Collection Receiver	Baghouse	95% (PM/PM ₁₀)
S5 & S6	DDGS Cooling System	Baghouse	95% (PM/PM ₁₀) 65% (VOC/HAP)
S7	DDGS Transfer	Baghouse	95% (PM/PM ₁₀)
S9	DDGS Loadout (Rail)	Baghouse	95% (PM/PM ₁₀)
S10	CO ₂ Scrubber / RTOs / Dryers / Various Processes	Scrubber/RTO RTOs	95% (VOC/HAP) 90% (PM/PM ₁₀) 96% (CO) 99% (VOC)
S11	Package Boilers	None	N/A
S12	Ethanol Loadout	Flare	98% (VOC)
S13	Anaerobic Treatment Module	Flare	98% (VOC)
S14	Emergency Firewater Pump	None	N/A
S15	Cooling Tower with Mist Eliminators	None	N/A
Source ID	Description	Type of Control	Efficiency

S16	Ethanol Loadout (Barge)	Flare	98% (VOC)
S17	DDGS Loadout (Barge)	None	N/A
Area 1	Wet Cake Storage / Handling	None	N/A
Area 2	Ammonia Tank	None	N/A
Area 3	Fugitives	None	N/A
Area 4	Paved Roads	None	N/A
Area 5	Various Process Vents	None	N/A
Area 6	Barge transfer fugitives (grain/DDGS)	None	N/A

Emission factor and their source for the Ethanol Plant and the Biodiesel Plant

The Four Rivers ethanol facility has calculated maximum emissions with emission factors based on AP-42, manufacturer's guarantees, stack test data from similar sources, and engineering analysis. In addition, the TANK 4.09d software program was used to perform tank emissions calculations.

Applicable regulations for the Ethanol Plant and the Biodiesel Plant

401 KAR 59:010, *New process operations*, is applicable to an emissions unit commenced on or after July 2, 1975.

401 KAR 59:015, *New indirect heat exchangers*, is applicable to an emissions unit with a capacity of less than 250 mmBtu/hr which commenced on or after April 9, 1972. Total heat input capacity = 150 + 150 + 51.2 mmBtu/hr = 351.2 mmBtu/hr.

40 CFR 60 Subpart Kb, *Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced after July 23, 1984*, is applicable to storage tanks since which storage vessel has a capacity greater than 75 cubic meters (19,812.9 gallon) that is used to store volatile organic liquids (VOL) for which construction, reconstruction, or modification is commenced after July 23, 1984.

40 CFR 60 Subpart VV, *Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry*, is applicable to affected facilities in the synthetic organic chemicals manufacturing industry that commences construction or modification after January 5, 1981. The Subpart VV regulates emissions of VOCs from equipment leaks (valves, flanges, pump seals, etc).

40 CFR 60 Subpart IIII, *Standards of Performance for Stationary Compression Ignition Internal Combustion Engines*, is applicable to the emergency generator that commence construction after July 11, 2005 and manufactured as a certified National Fire Protection Association (NFPA) fire

pump engine after July 1, 2006.

401 KAR 63:010, *Fugitive Emissions*, is applicable to each affected facility as an apparatus, operation, or road which emits or may emit fugitive emissions provided that the fugitive emissions from such facility are not elsewhere subject to an opacity standard within the administrative regulations of the Division for Air Quality.

401 KAR 63:015, *Flares*, is applicable to an emissions unit which means a device at the tip of a stack or other opening used for the disposal of waste gas streams by combustion.

401 KAR 63:020, *Potentially hazardous matter or toxic substances*, is applicable to an emissions unit which emits or may emit potentially hazardous matter or toxic substances, provided such emissions are not elsewhere subject to the provisions of the administrative regulations of the Division for Air Quality.

Applicable regulations for the Biodiesel Plant only

40 CFR 60 Subpart Dc, *Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units*, is applicable to these boilers since each boiler for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 mmBtu/hr) or less, but greater than or equal to 2.9 MW (10 mmBtu/hr).

Applicable regulations for the Ethanol Plant only

40 CFR 60 Subpart Db, *Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units*, applies to steam generating unit that commences construction, modification, or reconstruction after June 19, 1984, and that has input capacity from fuels combusted in the steam generating unit of greater than 29 MW (100 mmBtu/hour). Since the units will be constructed after February 28, 2005 and will only burn natural gas, there are no limits for SO₂ or PM, but there are NO_x emission standards.

EMISSION AND OPERATING CAPS DESCRIPTION:

In order to ensure that the facility remains exempt from the regulations for major sources of criteria and HAP emissions, Four Rivers is requesting a conditional major permit. Emissions will be limited to less than 90 ton/yr VOC, 24.73 ton/yr of total HAP, and 9 ton/yr of an individual HAP. Four Rivers has also requested source-wide limits for PM, PM₁₀, SO₂, NO_x, and CO. Monthly and rolling 12-month total emissions for PM, SO₂, NO_x, CO, and VOC will be calculated. Daily and rolling 365-day total emissions for PM₁₀ and total HAP will be calculated since these emissions are close to the major source thresholds. Emission calculations and supporting documentation will be retained at the facility.

PERIODIC MONITORING:

See the permit for Specific Monitoring Requirements, which include: the raw material processed rate; fuel grade biodiesel and ethanol production rate; monitoring of the RTO, flare, and scrubber; and 40 CFR 60 VV compliance monitoring for fugitives.

OPERATIONAL FLEXIBILITY:

The power boiler at the biodiesel plant will only operate when the ethanol plant boilers are not operating.

CREDIBLE EVIDENCE:

This permit contains provisions which require that specific test methods, monitoring or recordkeeping be used as a demonstration of compliance with permit limits. On February 24, 1997, the U.S. EPA promulgated revisions to the following federal regulations: 40 CFR Part 51, Sec. 51.212; 40 CFR Part 52, Sec. 52.12; 40 CFR Part 52, Sec. 52.30; 40 CFR Part 60, Sec. 60.11 and 40 CFR Part 61, Sec. 61.12, that allow the use of credible evidence to establish compliance with applicable requirements. At the issuance of this permit, Kentucky has only adopted the provisions of 40 CFR Part 60, Sec. 60.11 and 40 CFR Part 61, Sec. 61.12 into its air quality regulations.